Nonlinear Characterization of Phase-change Switches for Reconfigurable Millimeter-wave Front-ends

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Thin films of phase change materials, such as VO_2 or GeTe, exhibit conductivity shifts of four or more orders of magnitude in response to thermal or electrical stimuli. For instance, heating VO_2 to 340K triggers an insulator-to-metal transition. Switches based on these materials span an application gap that exists between solid-state switches and MEMS switches. Although solid-state devices are able to switch at GHz rates, they are highly nonlinear and extremely lossy. Conversely, MEMS switches are both low-loss and linear, at the expense of switching speed and reliability. However, fast-switching VO_2 devices have been fabricated that exhibit low insertion loss ($< 0.5\,\mathrm{dB}$) at millimeter wave (MMW) frequencies while operating in a highly linear regime. These properties mark the switches for potential use in MMW transceiver front-ends where power handling requirements are high (TX) and low insertion loss is critical for efficiency (TX) and low noise figure (RX). Although, as stated, preliminary investigations suggest these switches are highly linear, a full nonlinear characterization of these VO_2 switches has yet to be conducted. A more rigorous nonlinear treatment of these switches would include a description of nonlinearities at different thermal and electrical operating points. Additionally, as these devices respond to thermal variations, we expect to observe memory effects due to heating and cooling of the VO_2 switches during operation. Therefore, we will present the results of two-tone tests over both the thermal and electrical operating ranges of these switches, as well as our investigations into the degree to which memory effects appear during switch operation.